An Approach to LabVIEW Based Temperature & Relative Humidity Monitoring System

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***Abstract*- This paper presents a PC based temperature and relative humidity monitoring system using virtual instrumentation (LabVIEW). Here I have measured the ambient temperature in degree Celsius using AD 590 IC temperature sensor. The current signal generated by the sensor and then converted to a voltage signal in the range of 0-4.5V using the signal conditioning circuit. This voltage signal is then fed to the PC using NI CARD-USB 6009. A graphical program is developed in LabVIEW to convert the received voltage signal to temperature, represent the continuous variation of temperature with voltage and also to display the ambient temperature of atmosphere. LabVIEW represents the continuous variation of relative humidity with ambient temperature graphically and theoretically using empherical equation. It also keeps record of the relative humidity and corresponding temperature, which are stored as numeric value in Excel file and perform as backup.**

***Keyword*- Relative humidity, Dry bulb and wet bulb temperature, Psychrometry method, LabVIEW.**

I. INTRODUCTION

Humidity is the amount of water vapor in air or other gases. Relative humidity is the ratio of actual water vapor to the maximum water vapor possible in air at a given temperature or the ratio of actual partial pressure of water vapor to the saturation vapor pressure of water. LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) is a visual programming language commonly used for Data Acquisition (DAQ). The major problem with humidity sensing is that the measurement device must be contact with environment. The various standardize methods to measure humidity are wet bulb and dry bulb psychrometer, chilled surface condensation hygrometers, chilled mirror hygrometers etc.

In this paper, I have proposed a technique to calculate percentage of relative humidity in LabVIEW using empherical equation. Here I have used wet bulb-dry bulb psychrometry method because the psychrometer is a fundamental measurement system. It is very popular method for its simplicity with low cost.

A. The purpose of choosing this method to calculate relative humidity through psychrometric chart

Psychrometry method works on the principle of the depression of the temperature caused by the evaporation of water from a saturated 'wick' covering a temperature probe. The decrease in temperature is directly related to the humidity of the air and in combination with a dry bulb measurement of temperature. Humidity can be derived from the psychrometric equation. I have used two AD590 for temperature sensors, one for dry bulb and another for wet bulb. Also I have inserted the sensor into the water bath for long period of time. Three long different colored wires are soldered to the three legs (Positive terminal - Red wire, Negative terminal - Blue wire, body terminal - Black wire) of the sensor and inserted in a hard plastic tube. Then they are sealed with ARALDITE (a standard adhesive).So, the proper mechanical protection is taken to avoid short circuit or damage of the sensor. It also protects the sensor against long exposure to high temperature and proper sensor fabrication is done. Dry bulb and wet bulb voltage signals from the signal conditioning circuit are received by the DAQ assistant box. The signal is then converted into temperature in degree Celsius using suitable program in LabVIEW. With the help of one empherical equation here I have calculated relative humidity. A continuous temperature trend also displayed with the help of LabVIEW and data storage is also possible for future use.

B. Formula for calculating relative humidity:

The following equations allow relative humidity to be calculated given the known parameters, dry bulb and wet bulb temperature and station level pressure.

$$RH = \frac{\left[\exp\left[1.8096+\left(\frac{17.2694\,T_w}{237.3+T_d}\right)\right]-7.866\times10^{-4}\,P\left(T_d-T_w\right)\left[1+\frac{T_w}{610}\right]\right]}{\left[\exp\left[1.8096+\left(\frac{17.2694\,T_d}{237.3+T_d}\right)\right]\right]} \quad \ldots\ldots (1)$$

Where RH= Relative humidity (%); T_d = Dry bulb temperature (^{o}C); T_w = Wet bulb temperature (^{o}C); P = Station level pressure (hPa).

If pressure is not known, the following table of standard pressures can be used as a first guess.

TABLE I.1: TABLE FOR STANDARD PRESSURE

Station Altitude (m)	0-250	251-500	501-750	1001-1250
Pressure(hPa)	998.3	969.0	940.4	912.5

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Section 2 represents the scheme followed in encryption technique. Section 3 gives you an idea about the experimental results. Section 4 is an analytical discussion on the technique. Section 5 draws a conclusion.

II. THE SCHEME

This section represents a description of the actual scheme used during "An Approach to LabVIEW Based Temperature & Relative Humidity Monitoring System" technique. In Section 2.1 I have described the hardware implementation process and in Section 2.2 I have described the software implementation process [2] [3] [4].

A. Hardware Implementation:

Here I have used AD590 as a temperature sensor to produce a current output in order of μA (~1μA / °C) proportional to ambient temperature. The corresponding voltage is taken using one suitable resistance. That voltage fed to the signal conditioning circuit. This circuit consist s of one amplifier and zero and span adjustment circuit to get the 0-5V range voltage.

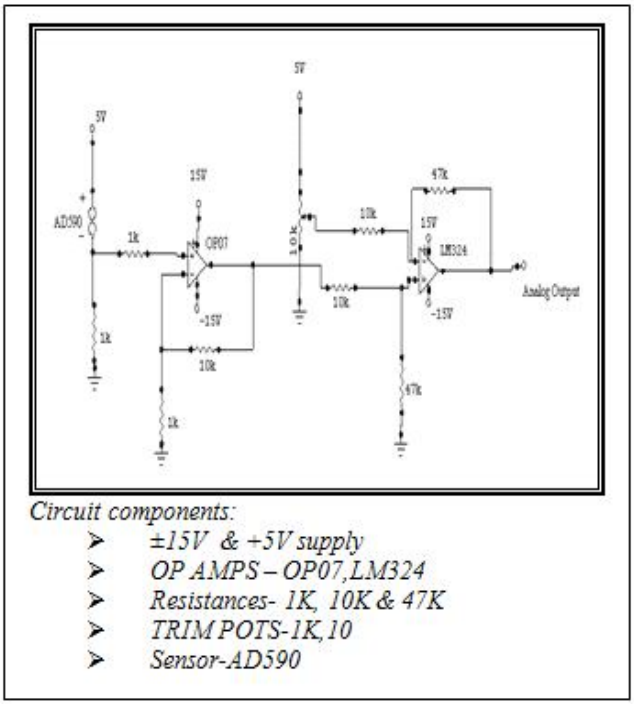

Figure 2.1: Temperature sensing circuit

After getting the ultimate voltage (0-5V) from hardware circuit I have used one NI-6009 USB card to interface it to LabVIEW software.

B. LabVIEW based implementation:

After interfacing the real values, which is measured by the hardware circuit, are taken by DAQ Assistant box to LabVIEW block diagram (Fig.3.3). Here I have build one graphical program for monitoring ambient temperature and relative humidity continuously using equation (i).this equation is putted in the Formula Dialog Box in LabVIEW block diagram.

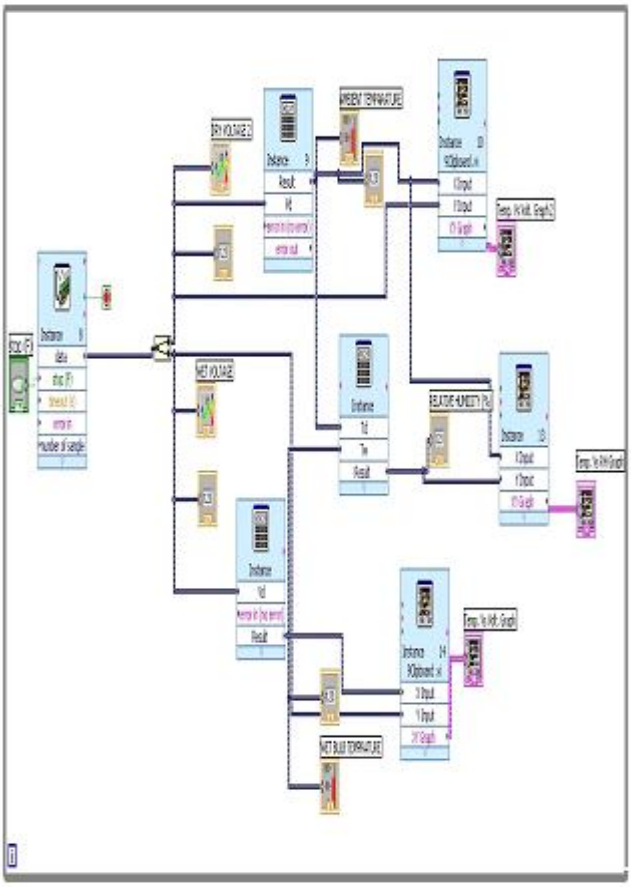

Figure 2.2: LabVIEW block diagram

III. EXPERIMENTAL RESULT

After span and zero adjustment I have got the data (Table 3.1) from the hardware circuit. This data has been fed to the LabVIEW block diagram and I got front panel (Figure 3.3) which represents the final output.

TABLE III.1: O/P OF LM324

Temperature(°C)	Dry bulb O/P(V)	Wet bulb O/P(V)
25	1.32	1.32
30	1.65	1.7
35	1.8	1.8
40	2.1	1.9
45	2.3	2.26
50	2.48	2.44
55	2.82	2.68
60	3.20	2.89
65	3.37	3.1
70	3.53	3.42
75	3.65	3.65
80	3.83	3.82
85	4.00	3.97
90	4.19	4.13
95	4.35	4.26

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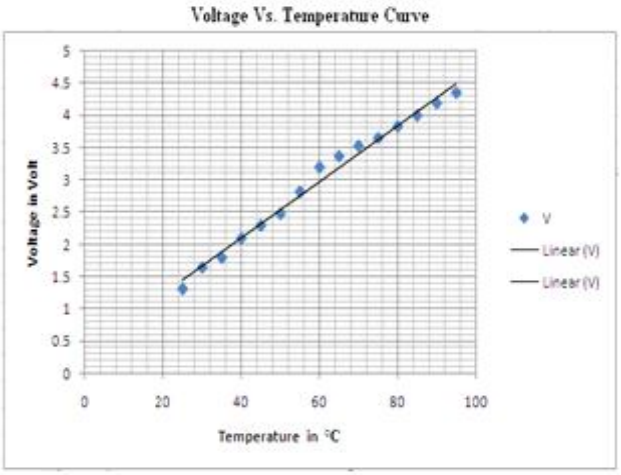

Figure 3.1: Voltage output for zero adjustment circuit for dry bulb

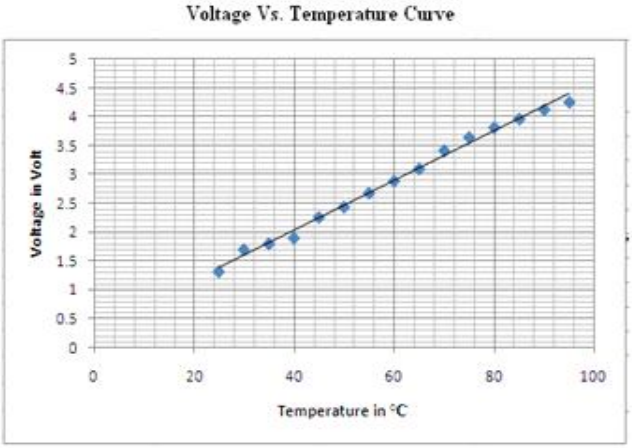

Figure 3.2 Voltage output for zero adjustment circuit for wet bulb

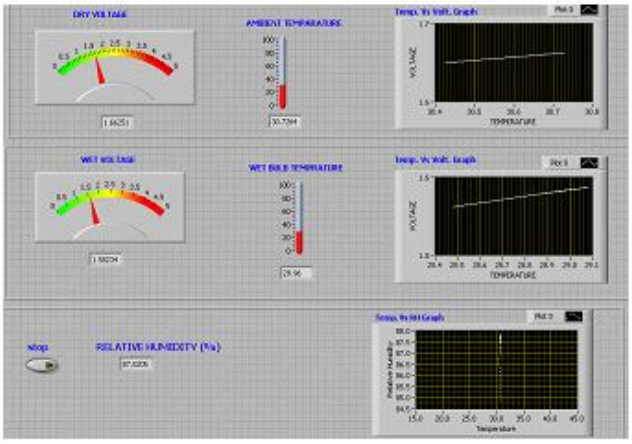

Figure 3.3: LabVIEW front panel

IV. ANALYSIS

According to the front panel (fig.) when dry bulb temperature is 30.7264 °C and wet bulb temperature is 28.96 °C then using the empherical equation, the calculated relative humidity is 87.0205%. Here dry bulb temperature is actually the ambient temperature of air. Any one may also get this result from the psychometric or Mollier diagram (fig 2.3) and psychrometric table. But the result what we get from the above methods sometimes be fractionally incorrect. At the time to compute the result from the diagram or chart, we only obtain the integer values in the approved manner. In addition we guess the fractional part and add it to integer part to get the final outcome. Using my method any one may get the exact value at any instant of time. Here there is no requirement to assume any fractional assessment and add it to any other numeral. I think it performances the better resolution than the previous methods.

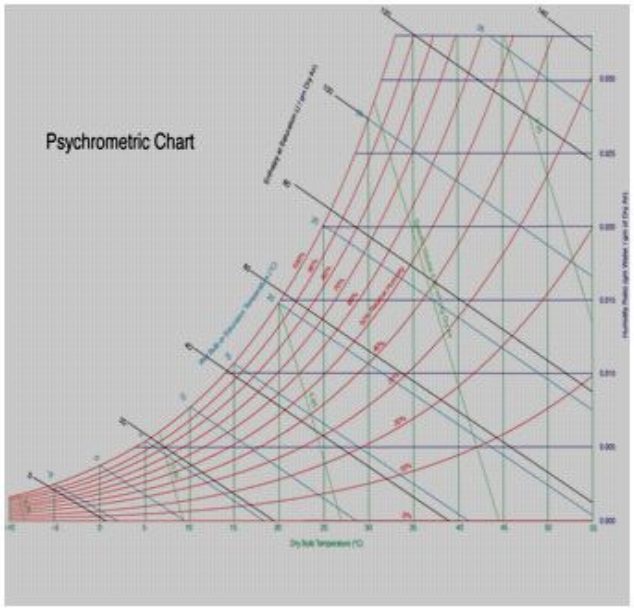

Figure 4.1: Psychrometric chart

TABLE IV.1: PSYCHROMETRIC TABLE

Relative Humidity Table (wet/dry bulb method)

Dry Bulb (°C)	Wet Bulb depression (°C)														
	0	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
2	99%+	84%	68%	52%	37%	22%	8%									
4	99%+	85%	70%	56%	42%	29%	26%	3%								
6	99%+	86%	73%	60%	47%	34%	22%	11%								
8	99%+	87%	75%	63%	51%	39%	28%	18%	7%							
10	99%+	88%	76%	65%	54%	44%	33%	23%	14%	4%						
12	99%+	89%	78%	67%	57%	47%	38%	29%	20%	11%	3%					
14	99%+	89%	79%	69%	60%	51%	42%	33%	25%	17%	9%					
16	99%+	90%	80%	71%	62%	54%	45%	37%	29%	22%	14%					
18	99%+	91%	81%	73%	64%	56%	48%	41%	33%	26%	19%	6%				
20	99%+	91%	82%	74%	66%	58%	51%	44%	37%	30%	24%	11%				
22	99%+	91%	83%	75%	68%	60%	53%	46%	40%	34%	27%	16%	5%			
24	99%+	92%	84%	76%	69%	62%	55%	49%	43%	37%	31%	20%	9%			
26	99%+	92%	85%	77%	70%	64%	57%	51%	45%	39%	34%	23%	14%	4%		
28	99%+	92%	85%	78%	72%	65%	59%	53%	47%	42%	37%	26%	17%	8%		
30	99%+	93%	86%	79%	73%	67%	61%	55%	49%	44%	39%	29%	20%	12%	4%	
32	99%+	93%	86%	80%	74%	68%	62%	56%	51%	46%	41%	32%	23%	15%	8%	1%
34	99%+	93%	87%	81%	75%	69%	63%	58%	53%	48%	43%	34%	26%	18%	11%	5%
36	99%+	93%	87%	81%	75%	70%	64%	59%	54%	50%	45%	36%	28%	21%	14%	8%
38	99%+	94%	88%	82%	76%	71%	65%	60%	56%	51%	47%	38%	31%	23%	17%	11%
40	99%+	94%	88%	82%	77%	72%	66%	62%	57%	52%	48%	40%	33%	26%	19%	13%
42	99%+	94%	88%	83%	77%	72%	67%	63%	58%	54%	50%	42%	34%	28%	21%	16%
44	99%+	94%	89%	82%	78%	73%	68%	64%	59%	55%	51%	43%	36%	29%	23%	18%

Using the LabVIEW we can create the database voltage vs. temperature in Excel file. That may use to get the relative humidity without using the hardware circuit to reduce the

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complexity of this method. Hence, the scopes of this development are reduction of cost, increasing human comfort, operation available over a wide humidity range, fast response at high and low humidity and real time reading.

V. CONCLUSION

The output of the AD590 sensor is a current signal in the µA range. Almost all type of signal conditioning is possible using LabVIEW. But the input module of µA range was not available in our laboratory; therefore I have implemented the signal conditioning using hardware circuitry. Here I have used AD590 IC as temperature sensor. This IC can measure temperature from -55ºc to +150ºc. Hence with this temperature measurement system I can only measure temperature within this range. Using this method, we may measure relative humidity in real range. I can't measure humidity below 0 ^{o}C because of our empherical equation. After all, it performances better resolution for real time temperature and relative humidity monitoring system than the other well known methods.

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